The Readout and Data Acquisition Design of the sPHENIX Detector at RHIC

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Abstract

The sPHENIX detector will be based on the former BaBar magnet and will include tracking detectors, a new electromagnetic calorimeter, and, for the first time at a RHIC experiment, a hadronic calorimeter. A new technology using a Tungsten-scintillating fiber design for the electromagnetic calorimeter is what enables the full azimuthal coverage, as it achieves a radiation length of just about 7mm, which allows for a very compact design of the device.

The calorimeter signals are sampled with silicon photomultipliers and waveform digitizing electronics. The digitized waveforms are read out with custom PCIe boards that allow multiple streams with bandwidths of up to 5GBit/s. The goal is to have a sustained event rate to disk of about 15KHz. Focusing on the calorimeters, we will describe the goals and design of the sPHENIX experiment, the design of the digitizers and other parts of the data acquisition system.

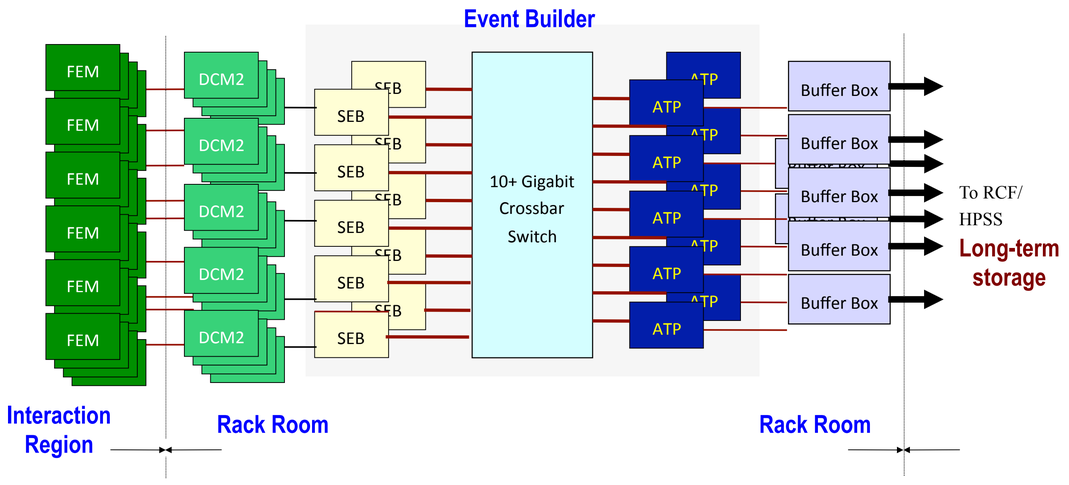
Two different DAQ architectures in one

- The inner tracking system and calorimeters use a classic triggered readout
- The TPC must use a continuous – "streaming" - readout
- The streaming TPC data must be trimmed and aligned with the triggered events

Performance Specifications

- 15KHz Event rate
- 40-60GBit/s fully compressed data rate to storage
- 150 Gbit/s instantaneous data rate

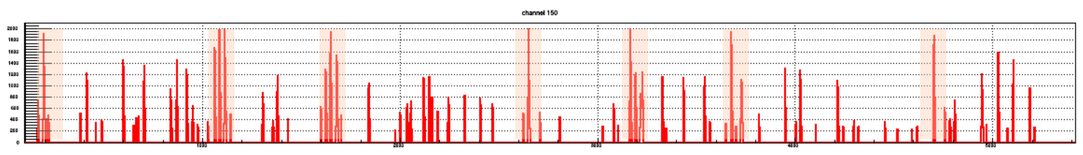
Event Builder for the triggered readout



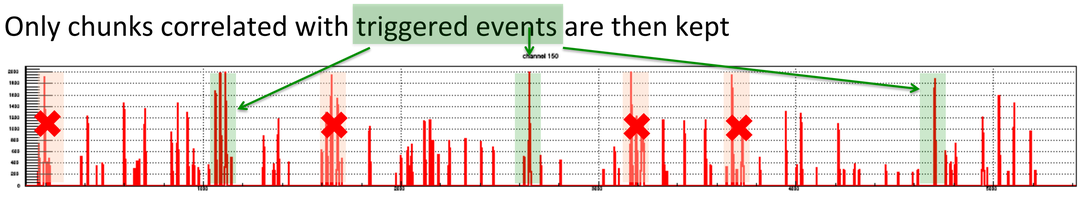
- DCM-2 receives data from digitizer, zero-suppresses and packages
- SEB collects data from a DCM group
- ATP Assembles events and compresses data
- Buffer Box data interim storage before sending to the computing center

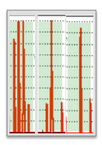
Flow Diagram for the streaming readout

The streaming data are recorded all the time, and broken up in chunks above threshold

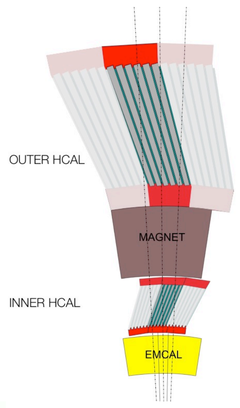


Only chunks correlated with triggered events are then kept

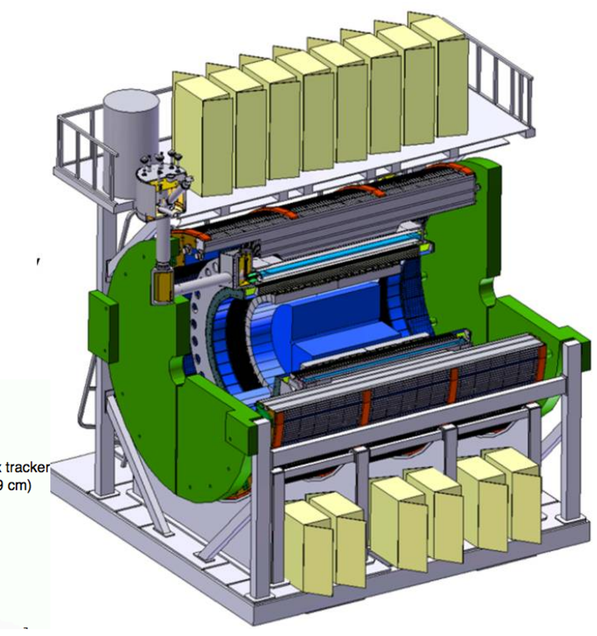


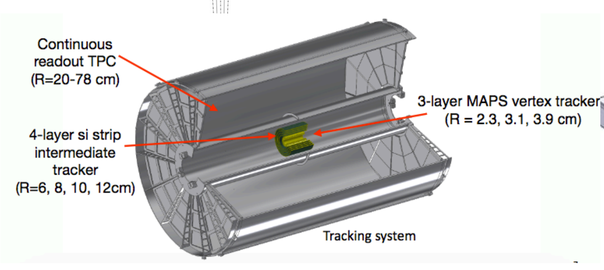


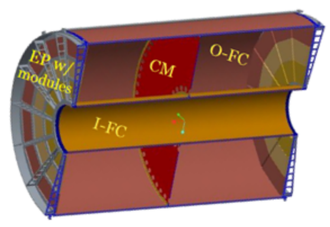
This results in a greatly reduced data stream
The real-time processing demands are very high



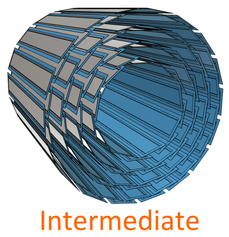
sPHENIX



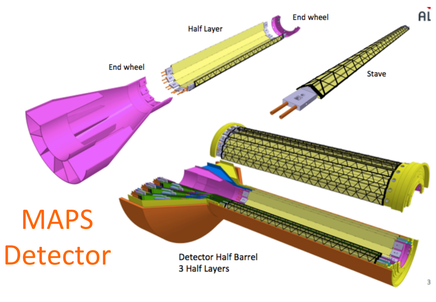




TPC

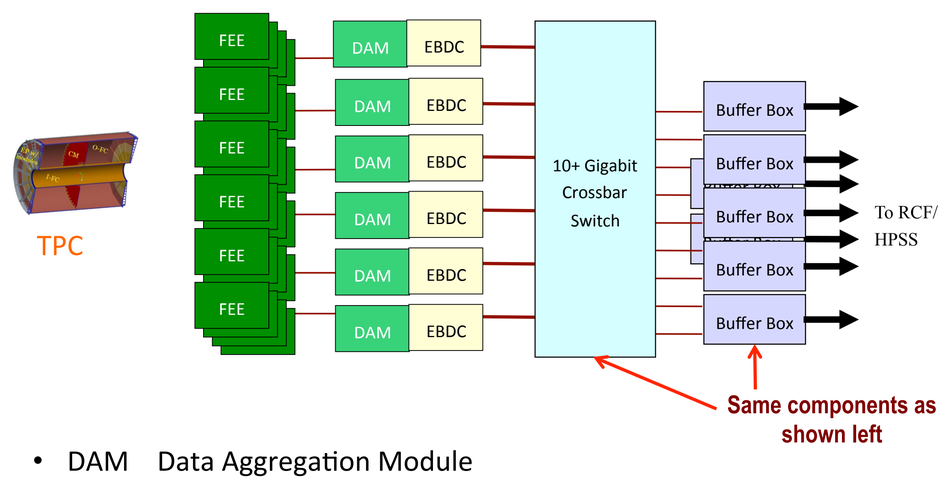


Intermediate Tracker



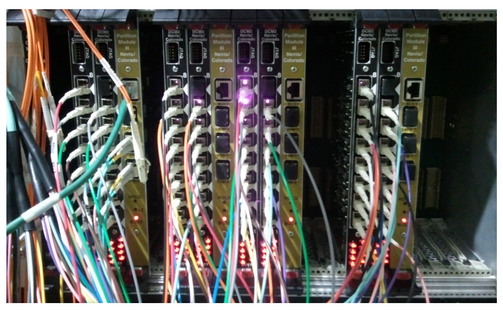
MAPS Detector

Flow Diagram for the streaming readout



- DAM Data Aggregation Module
- EBDC Event Buffering and Data Compressor

Hardware



DCM-2s from the PHENIX experiment

ATLAS FELIX card
(TPC Readout candidate)

Summary

- Solid concept to combine triggered and streaming readout
- Re-used PHENIX readout electronics well understood
- FPGA/PCIe card selected
- Verification of achievable data reduction ongoing

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